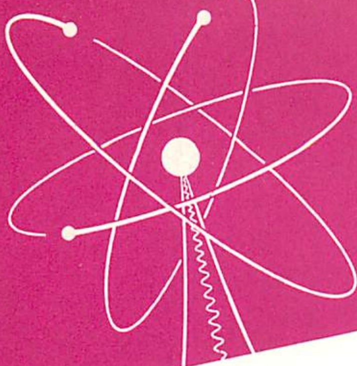

COLOR RECEIVER INSTALLATION

Lesson T4E-13A

DeVRY Technical Institute
4141 W. Belmont Ave., Chicago 41, Illinois
Formerly DeFOREST'S TRAINING, INC.

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T4E-13A

COLOR TV
RECEIVER INSTALLATION

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DeVRY Technical Institute
Chicago 41, Illinois

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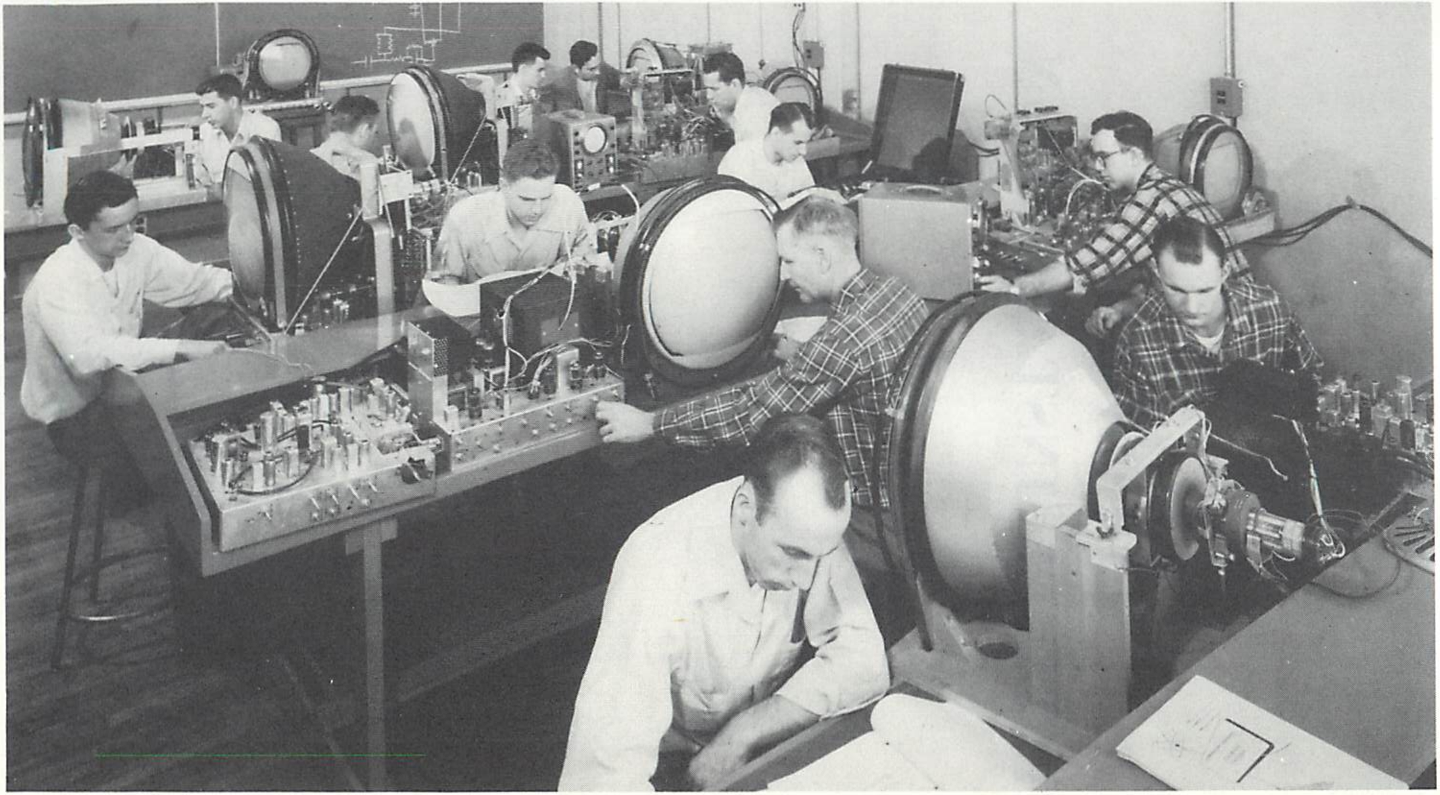


A group of students in a D.T.I. Laboratory studying the theory and servicing of color TV receivers. Both the magnetic and electrostatic convergence picture tubes are employed in the various receivers.

DTI Photo

COLOR TV RECEIVER INSTALLATION

Contents

PAGE

Set-up Procedure—Electrostatic Convergence Tube 4

  Preliminary Adjustments 4

  Purity Adjustments 6

  Convergence Adjustments 8

  Black-and-White Adjustments 13

  Summary of Set-up Procedure 14

Set-up Procedure—Magnetic Convergence Tube 16

  Preliminary Adjustments 16

  Preliminary Convergence Adjustments 18

  Purity Adjustments 20

  Convergence Adjustments 21

  Summary of Set-up Adjustments 25

Antenna Requirements 28

Use of the Color Stripe 29

Customer Instruction 30

> **"One Picture is Worth 10,000 Words".**
> **—An Old Chinese Proverb**

COLOR TV RECEIVER INSTALLATION

The average black-and-white television receiver can be installed without too much time and effort as the number of adjustments that must be made are few and relatively simple. Unfortunately, this is not always true of present day color receivers and it may require considerable time to make all of the necessary set-up adjustments.

Due to the three-gun construction of the color picture tube, the beams must be controlled so that each beam strikes the correct phosphor dots. That is, the red beam must strike only red dots, the blue beam must strike only blue dots and the green beam must strike only green dots. When each beam strikes the correct set of dots, color purity is obtained. The beams also must be controlled so that they cross over or converge at the openings in the shadow mask by performing the convergence adjustments. Finally, it is necessary to adjust the conduction of the three beams so that the phosphors emit the same amount of light for a good black and white picture.

All of these set-up adjustments are based upon the assumption that the receiver is not defective in any way and requires only the adjustments concerning the picture tube to obtain normal operation. These adjustments may be necessary if the control settings have been disturbed in crating and shipping the receiver, or if the picture tube is shipped separately from the remainder of the receiver. In this latter case, the physical installation of the picture tube will depend upon the construction of the receiver and the manufacturer's instructions are to be followed.

In many cases, all of the set-up adjustments have been made at the factory and only the normal installation adjustments, such as size, linearity, centering, agc, etc., will be necessary. However, the color television technician must be capable of performing the complete set-up procedure as he will undoubtedly be called upon to do so many times.

Since the set-up procedure for the electrostatic convergence type picture tube is considerably different than the set-up procedure for the color picture tubes using magnetic convergence, a complete coverage of each type will be given.

SET-UP PROCEDURE—ELECTROSTATIC CONVERGENCE TUBE

Preliminary Adjustments

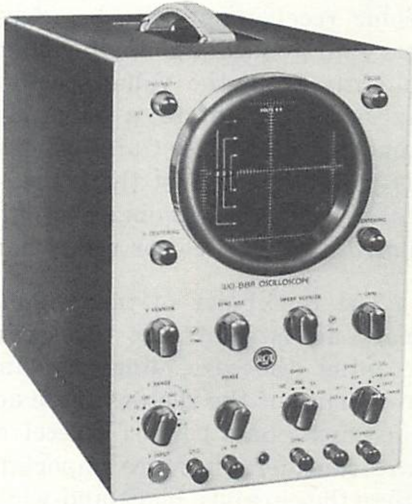
Several preliminary steps must be taken before the purity and convergence adjustments are made. Therefore, a black-and-white picture should be tuned in and the agc control (if used) adjusted for the best possible picture. Next, the action of the horizontal hold control should be checked and the horizontal afc circuits should be adjusted in the same manner as in a black-and-white receiver. The vertical hold control should also be varied to see that it gives the proper action. For all preliminary adjustments, disregard any color contamination or fringes due to improperly adjusted purity and convergence controls.

If a transmitted test pattern is available, it can now be used to make the remainder of the preliminary adjustments. In most cases, however, the technician will find it necessary to use the signal from a cross hatch generator. Usually, the quickest way to do this is to use a generator which produces a modulated r-f signal and feed its output to the antenna input terminals.

After setting the receiver and the generator on the same channel, adjust the horizontal and vertical bar controls of the generator until the crosshatch pattern on the face of the picture tube is synchronized.

The high voltage adjustments are next in line. A high voltage probe and vtvm or a 20,000 ohms per volt meter capable of measuring at least 30,000 volts should be used. As explained in an earlier lesson, variations in the picture tube beam current cause fluctuation of the high voltage which also affect the focusing and convergence of the beams.

To prevent this undesirable action, the high voltage is regulated. In most receivers employing the electrostatic convergence type picture tube, the high voltage should be adjusted for about 19,000 volts. The exact amount may be a few hundred volts more or less than this depending upon the manufacturer's specifications and should be adjusted accordingly.



A typical example of the type of oscilloscope that will be found in many service shops. It is excellent for most TV service work.

Courtesy Radio Corporation of America

With the high voltage probe connected to measure the CRT second anode voltage, the potentiometer that varies the bias on the high voltage regulator tube should be adjusted for the correct high voltage. The brightness and contrast controls should be rotated over their usable range and variations in the high voltage, as the controls are rotated, should not be more than 1,000 volts. In some receivers it may be necessary to reduce the high voltage slightly from the value specified in order to obtain a minimum amount of change. Quite often it is possible to adjust the horizontal drive control to obtain a higher voltage with better regulation.

The remainder of the preliminary adjustments are those concerning the size, linearity and centering of the raster. These adjustments on a color TV receiver are considerably more important than they are on a black-and-white receiver because improper setting of these controls may make it impossible to obtain good purity and convergence. For best results, the visible portion of the raster should not exceed the limits of the decorative mask by more than one quarter inch. If it is necessary to adjust the horizontal drive control or any of the horizontal size controls a considerable amount, a recheck of the high voltage should be made.

Purity Adjustments

Color purity means that when the green and blue guns are not conducting, the electron beam emitted by the red gun will strike only the red phosphor dots and the entire area of the screen will be red. This same condition must exist in regards to the other two guns. That is, when only the blue gun is conducting, the screen should be completely blue and when only the green gun is conducting the screen should be completely green. In order to accomplish this, the field coil, the purity coil and the deflection yoke must be properly adjusted.

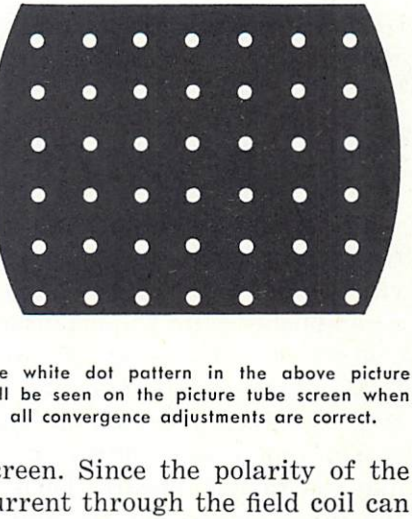
An important point to keep in mind is that adjustment of the purity coil current or position affects all three beams at the same time and it is usually necessary to make purity adjustments for only one gun. Since the red phosphor is the most inefficient and requires more beam current than the other two, purity adjustments are usually made while viewing the red field.

After all components have been properly positioned on the neck of the picture tube and the field neutralizing coil (or rim coil) is placed around the front of the tube, the field coil is disconnected or the field control is set to its mid-position. This is done to prevent the field coil from having any effect upon the purity coil adjustment. The screws holding the deflection yoke are loosened and the yoke is moved as far toward the base of the CRT as possible without disturbing the position of the purity coil. The green and blue screen controls should be turned to their minimum settings and the red screen control adjusted for maximum.

In order to prevent the magnetic field from the purity coil interacting with any of the other fields, the current through the purity coil should be kept as low as possible. Therefore, set the purity control to its maximum counterclockwise position and rotate the purity coil around the neck of the picture tube until a pure red is produced at a small area in the center of the raster. If this condition cannot be obtained, increase slightly the current through the purity coil (adjust the purity control) and once again rotate the purity coil for best results. Repeat this procedure until a pure red area can be obtained at the center of the raster. Disregard any neck shadows or impurities that occur at the edges of the tube face.

When a pure red is obtained in the center of the screen, move the deflection yoke towards the bell of the picture tube until the purest overall red area is obtained. At this point, impurities around the extreme edges of the tube face can be neglected as this condition can be corrected by the field neutralizing coil. It is possible that the movement of the yoke will affect the purity coil setting and a slight readjustment of the position of the purity coil and the purity control will improve the overall purity.

The field neutralizing coil can now be energized and the current through it adjusted for a pure red raster at all points on the screen. Since the polarity of the current through the field coil can be reversed as well as the amplitude changed, vary the field coil control throughout its entire range to note the effects. This procedure will enable the best setting to be determined.



The white dot pattern in the above picture will be seen on the picture tube screen when all convergence adjustments are correct.

The next step is to check the purity of the green and blue fields. This is done by turning the red screen control down and the blue screen control up; then turn the blue screen control down and the green screen control up. In each case, the raster should be examined for impurities, and the purity procedure repeated if either field is not pure.

In some receivers it may be impossible to adjust the controls so that all three fields are absolutely pure and it will be necessary to make compromise adjustments to obtain the best all around results.

After the purity adjustments have been completed, tighten the yoke in place, being careful not to move it. Any movement of the yoke will affect the purity of the fields and necessitate a repeat of the purity procedure.

The screen, brightness and contrast controls should be set to provide a dim white raster. This is accomplished with the brightness control set at maximum, the contrast control at minimum and the screen controls at minimum. Turn up the red screen control until a dim red raster appears. Turn up the green screen control until a dim yellow raster appears; then turn up the blue screen control until a dim white raster appears. Finally, apply a signal to the receiver and readjust the size and centering controls if necessary.

Convergence Adjustments

The convergence adjustments are for the purpose of causing the three electron beams to cross over or converge at the openings in the shadow mask as the beams are deflected over the screen area. The entire procedure is usually divided into the static (or d-c) convergence adjustments and the dynamic convergence adjustments. Even though the beams are always being deflected during the actual set-up procedure, the center of the raster can be used for the static adjustments and the edges of the raster can be used for dynamic adjustments. When all adjustments have been made properly, the pattern from a white dot generator should appear on the screen as shown in Figure 1.

Before the beams can be converged properly, it is necessary that they enter the converging field so that, looking from either end of the tube, the separate beam positions form an equilateral triangle around the central axis of the tube. Since it is practically impossible to physically position the guns with such precise accuracy, three beam-positioning magnets are used to achieve this alignment. These magnets are positioned around the neck of the tube so that the one affecting the blue beam is pointed directly toward the blue gun and the other two are similarly placed in respect to the red and green guns.

To make the adjustments, the signal from a white dot generator is fed into the receiver and the receiver is tuned until a pattern similar to Figure 1 is obtained. Whether the dots are round or square is unimportant and will depend upon the type of dot generator being used. At this point, the dots are probably not pure white but have color fringes. This is normal before the convergence adjustments have been made.

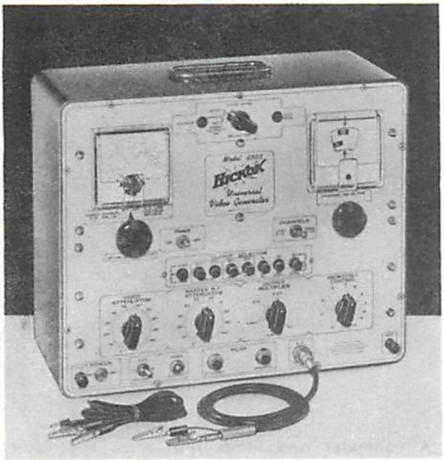
The d-c convergence control is now adjusted to cause the beams to spread and produce dot triangles consisting of one red, one blue and one green dot. The actual presentation on the screen depends upon the setting of the d-c convergence control and the placement of the guns in the neck of the picture tube. If the guns are placed (looking from the face of the picture tube) as shown in Figure 2, the beam motion due to the direct voltage on the convergence electrode will be as indicated by the arrows in Figure 2. Making the convergence electrode voltage more positive causes the beams to move away from the center of the triangle and making the electrode less positive causes the beams to move towards the center of the triangle.

A condition of under-convergence (d-c convergence voltage too high) is illustrated in Figure 3 while a condition of over convergence (d-c convergence voltage too low) is illustrated in Figure 4. A condition of over convergence exists when the beams cross over before they reach the shadow mask while under convergence means that the beams have not crossed over when they pass through the openings in the shadow mask.

A voltmeter and leads that were specifically designed for making high voltage measurements up to 30,000 volts.

Courtesy Beta Electric Co.

For best results, the dynamic convergence controls (horizontal and vertical) are set to their minimum positions and the d-c convergence control adjusted so that a condition of under-convergence, as shown in Figure 3, is obtained. The beam positioning magnets are now adjusted so that the dot trios in the center of the raster form an equilateral triangle. To prevent the magnetic field of each beam positioning magnet from affecting the magnetic fields of the purity coil and the other magnets, the magnets should be screwed out of their holders as far as possible. Then the beam-positioning magnets are screwed in just enough to obtain the desired results. As an aid in this adjustment, Figure 5 shows the direction of motion of the dots as the beam-positioning magnets are screwed in and out. If it is necessary, these magnets can be unscrewed completely and the opposite end inserted into the holder to obtain a greater range of adjustment. All dot trios except those in the center of the raster can be ignored while making these static convergence adjustments.



The versatile generator shown above puts out signals that produce several different patterns. Among these are the cross hatch and white dot patterns.

Courtesy Hickok Electrical Instrument Co.

After the dot trios in the center of the raster are formed into equilateral triangles, the d-c convergence control is adjusted to converge the center trio into a single white dot. Whenever any adjustment of the d-c convergence control is made, the focus control should be adjusted for the best focusing of the dots.

After the static convergence adjustments are made, the next step is to adjust the dynamic convergence circuits so that the beams will converge at the edges of the raster as well as in the center. The lack of convergence as the beam is deflected is due to the fact that the distance from the point of deflection to the edges of the screen is greater than the distance from the point of deflection to the center of the screen. With no dynamic convergence voltage applied to the convergence electrode as the beams are deflected to the edges of the screen, the beams "cross over" before they reach the shadow mask openings and a condition of over-convergence is obtained.

To prevent this condition of over-convergence at the edges of the screen, a parabolic voltage derived from the horizontal sweep circuits is applied to the convergence electrode which causes the instantaneous voltage to become more positive as the beam moves to either side of the center of the screen. This increasingly positive voltage spreads the beams farther apart and they are not permitted to converge until they reach the openings in the shadow mask. Another parabolic voltage derived from the vertical sweep circuits is also applied to the convergence electrode to obtain the same action in the vertical direction.

When the amplitude and phase of the horizontal and vertical dynamic convergence voltages are correct, the beams will converge properly at all points on the screen and the white dot pattern of Figure 1 will be seen. The dynamic focus voltages will be correct also as they are obtained from the dynamic convergence circuit.

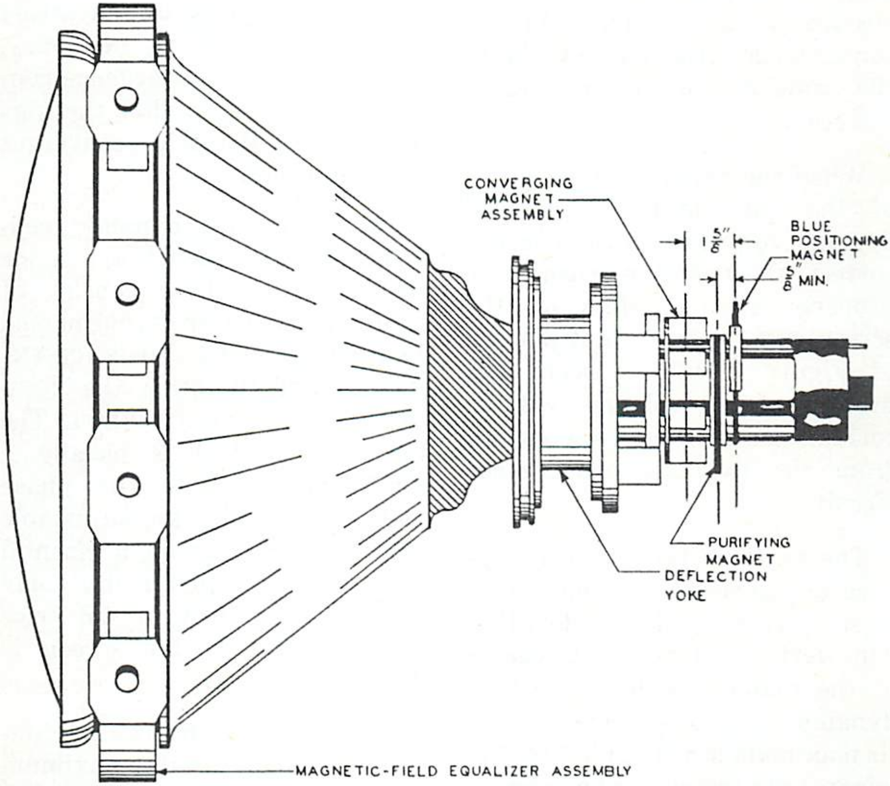
The vertical dynamic convergence adjustments are made first by observing the line of dots that runs vertically through the center of the raster. With the vertical dynamic amplitude control set to its maximum position (fully clockwise), the vertical dynamic shape or tilt control is adjusted until the top and bottom dot trios of the center vertical line are equally displaced as shown in Figure 6. Next, adjust the vertical dynamic amplitude control until all of the dot trios along this same vertical line are equally displaced as shown in Figure 7. This indicates that the vertical dynamic convergence adjustments are correct. It may be necessary to make slight readjustments of each control before this condition is obtained.

During these vertical convergence adjustments, the dots should be kept in focus by adjusting the focus control as necessary. Finally, the d-c convergence control is adjusted so that the vertical line of dot trios converges into white dots.

The horizontal dynamic convergence adjustments are made next. Usually these consist of adjusting two controls; one named the HORIZONTAL CONVERGENCE AMPLITUDE and the other the HORIZONTAL CONVERGENCE PHASE. The amplitude control is usually a potentiometer while the phase control is usually an adjustable coil. While making the horizontal convergence adjustments, only one horizontal row of dot trios in the center of the screen is observed.

First, set the horizontal amplitude control to its maximum clockwise position and adjust the horizontal phase control for maximum separation or divergence of the dots at the center of the line as shown in Figure 8.

Next, adjust the horizontal convergence amplitude control for equal separation of the dots in each trio all along the center horizontal line. It may be necessary to make slight adjustments back and forth between the amplitude and phase controls to obtain the results as shown in Figure 9.



This sketch shows the placement of the components used with a 21" magnetic convergence picture tube.

Finally, the d-c convergence control is adjusted so that the horizontal row of dots converges into a single line of white dots. At this point, the dots over the entire area of the screen should be converged into a pattern of white dots. In many cases it will be found that a small amount of color fringes will still be observed around the outermost portion of the screen. Sometimes this can be reduced to a minimum by repeating the convergence adjustments until complete familiarity is obtained with the action of the controls. Unfortunately, in some receivers it is not possible to obtain a condition of perfect convergence at all points on the screen.

Black-and-White Adjustments

For compatibility, further adjustments are made so that a black-and-white picture can be obtained from a black-and-white telecast signal. This procedure is quite important, too, since the colors reproduced on a color telecast will be improper if these latter adjustments are not set correctly. These black-and-white adjustments are necessary because the three phosphors do not emit the same amount of light when the operating voltages are the same. The red phosphor is the most inefficient, the green phosphor is more efficient while the blue phosphor is the most efficient.

For these adjustments tune the receiver to any local channel transmitting a monochrome signal and make the necessary adjustments to obtain a stable picture.

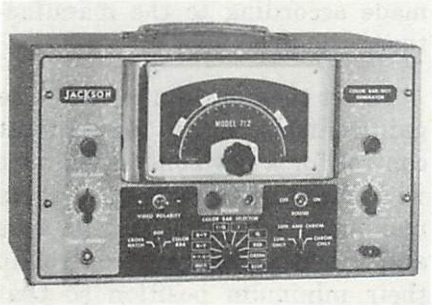
Turn the color saturation control to minimum, the contrast control to minimum and the brightness control to maximum. Turn the three screen controls to their minimum settings and then adjust the red screen control to obtain a dim red raster. Next, adjust the green screen control for a dim yellow raster and the blue screen control for a dim white raster.

In most receivers, the gain of the blue and green video amplifiers is variable so that the gain of these circuits can be reduced in respect to the gain of the red video amplifier. These blue and green video gain controls are usually made accessible to the technician. If so, the procedure explanations in the next paragraph apply. If not, the adjustments are made according to the manufacturer's instructions.

To set the blue and green video gain controls, adjust the contrast control for a low contrast picture with the brightness control at its maximum setting. Turn the blue and green video gain control to their minimum position so that the highlights in the picture appear red. Next, adjust the green video gain control so that the highlights appear yellow. Now adjust the blue video gain control so that the highlights appear white.

The final portion of the black-and-white adjustments is the setting of the background controls. First of all, reduce the setting of the brightness control and increase the setting of the contrast control so that a low-brightness picture is obtained. Turn the blue and green background controls to their minimum position. A low-brightness red picture should now be observed. Turn up the green background control until a low brightness yellow picture is obtained and finally, turn up the blue background control until a low level white picture is obtained.

As the contrast and brightness controls are turned over their entire usable ranges, no color tinting of the picture should occur. If so, the black and white adjustments should be repeated until proper conditions are obtained.



A crosshatch, white dot or variety of color bar patterns can be obtained from this generator. These signals are provided in the form of a video voltage or a modulated r-f voltage.

Courtesy Jackson Electrical Instrument Co.

Summary of Set-up Procedure

Now that the set-up adjustments have been covered in detail, a brief step-by-step procedure is summarized as follows:

1. Tune in a transmitted signal; adjust agc, horizontal hold and vertical hold controls.
2. Make any necessary adjustments to obtain proper synchronization.
3. Adjust the high voltage for about 19,000 volts and check the regulation as the brightness control is varied.
4. Using a crosshatch pattern, adjust for correct size and linearity of both sweep circuits.
5. Make the necessary centering adjustments and turn the contrast control to minimum.
6. De-energize the field neutralizing coil by removing the plug-in connector or setting its control at mid-position.
7. Loosen the deflection yoke screws and move the yoke as far towards the base of the picture tube as possible.
8. Turn the blue and green screen controls to minimum and the red screen control to maximum.
9. Turn the purity control to minimum.
10. Rotate the purity coil around the neck of the tube and adjust the purity control to obtain a pure red raster in the center of the screen.
11. Move the deflection yoke forward until the purest overall red area is obtained.
12. Energize the field-neutralizing coil and adjust the

field-neutralizing control for a pure red raster.

13. Check for impurities in the green and blue fields and make any necessary adjustments.
14. Tighten the yoke mounting screws without disturbing the position of the yoke.
15. Adjust the screen controls for a dim white raster.
16. With any signal applied, check the size and centering controls.
17. Using a white dot generator pattern, tune the receiver until the dots become stationary.
18. Set the dynamic convergence controls to their minimum positions.
19. Adjust the d-c convergence control to form under-converged dot trios.
20. Adjust the beam-positioning magnets so that the dot trios in the center of the screen form equilateral triangles. Ignore all other dot trios.
21. Adjust the d-c convergence control so that the center dot trios form single white dots.
22. Adjust the focus control as necessary throughout the procedure.
23. Set the vertical dynamic amplitude control to its maximum clockwise position.
24. Adjust the vertical shape control until the top and bottom dot trios have the same amount of divergence. Use only the vertical center line of dot trios.
25. Adjust the vertical dynamic amplitude control until the vertical center line of dot trios are equally diverged.
26. Repeat steps 24 and 25 as necessary.
27. Using the d-c convergence control, converge the center line of dot trios into a line of single white dots.
28. Set the horizontal dynamic amplitude control to its maximum clockwise position.
29. Adjust the horizontal dynamic phase control for maximum divergence at the middle of the horizontal line of dots. (Use only the horizontal center line of dot trios).
30. Adjust the horizontal amplitude control for equal separation of the dots in each trio along the center horizontal line.

31. Repeat steps 29 and 30 as necessary to make the entire row of dot trios form equilateral triangles.

32. Converge all dot trios into a white dot pattern by adjusting the d-c convergence control.

33. Check the appearance of the dots for color fringes and repeat the convergence procedure, if necessary.

34. Tune in a station and sync the picture.

35. Turn color saturation control and contrast control to minimum; brightness control to maximum.

36. Turn all screen controls to their minimum position.

37. Adjust the screen controls to obtain a dim white raster.

38. Set blue and green video gain controls to their minimum position.

39. Turn up the contrast control to obtain a low-contrast red picture.

40. Adjust the blue and green video gain controls for a low-contrast white picture.

41. Reduce the setting of the brightness control and increase the setting of the contrast control to obtain a low-brightness picture.

42. Turn the blue and green background controls to their minimum settings.

43. Adjust the blue and green background controls for a low-brightness white picture.

44. Check the black-and-white adjustments over the usable range of the brightness and contrast controls and repeat steps 34 to 43 if necessary.

SET-UP PROCEDURE—MAGNETIC CONVERGENCE TUBE

As with the electrostatic convergence tube it is necessary for several preliminary adjustments to be made before the purity and convergence adjustments are attempted. Since the exact procedure is not quite the same for both types of tubes, the complete procedure will be given even though some of the steps and explanations are a duplicate of the previous procedure.

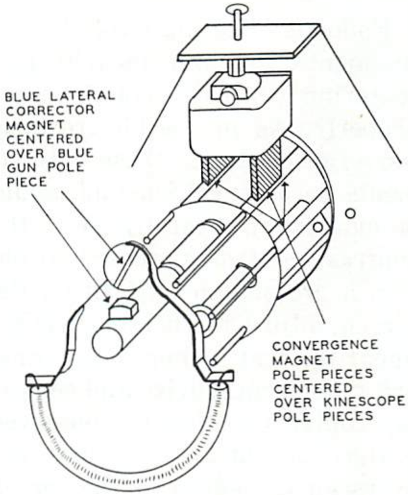
Preliminary Adjustments

Tune in a strong local station and adjust the agc control so that no overloading occurs. The action of the horizontal hold control should be checked and the horizontal afc circuits should be adjusted if necessary. The vertical hold control also should be checked for proper operation. These steps are necessary because the convergence circuits use signals from the deflection circuits. Thus the deflection circuits must operate at the correct frequencies to give the best results. While making these adjustments, disregard any color impurities or fringes due to improperly adjusted purity and convergence controls.

If a transmitted test pattern is not available, connect the output of a crosshatch generator to the receiver. This is best accomplished by setting the generator to produce a modulated r-f signal and feeding this signal to the antenna. With the receiver and generator tuned to the same channel, adjust the bar controls of the generator until the crosshatch pattern on the picture tube screen is stable.

The magnetic convergence picture tube also requires a regulated high voltage supply and it is now necessary to make the adjustments for the proper high voltage. Using a high voltage probe and a vtvm (or other suitable meter) which are capable of measuring at least 50,000 volts, measure the voltage that is applied to the ultor anode of the picture tube. With the brightness and contrast controls set to their minimum position, adjust the high voltage control for 25,000 volts (or to the value specified by the manufacturer). Now, advance the brightness control and notice the decrease in high voltage. If this decrease is more than 500 or 1000 volts (as specified), the high voltage control is adjusted until the decrease in voltage is within the specified limits.

If the brightness control is advanced beyond its usable limits, it is possible for the total beam current to be so great as to cause the regulator circuit to lose control. This condition will be evidenced by a sudden blooming of the picture or, in some cases, by a motorboating action which causes the raster to alternately expand and contract at a low frequency. In either case, reduce the setting of the brightness control so this does not occur.


BLUE LATERAL CORRECTOR MAGNET CENTERED OVER BLUE GUN POLE PIECE
CONVERGENCE MAGNET POLE PIECES CENTERED OVER KINESCOPE POLE PIECES

Sketch showing the location of the convergence and blue lateral corrector magnets on a 21" magnetic convergence picture tube.

In some receivers, the high voltage regulator tube may not require any high voltage adjustments and it is merely necessary to check the high voltage as the brightness control is varied. If insufficient high voltage is available, it may be due to an incorrect setting of the horizontal drive control, and an adjustment of the drive control may help to obtain better results.

Following the high voltage adjustments, the size, linearity and centering controls should be set properly. As in the electrostatic convergence tube, these adjustments are quite critical and should be made very carefully. With the contrast control increased to obtain a crosshatch pattern on the screen, adjust the height, vertical linearity, width, horizontal linearity, horizontal drive and centering controls so that the observed pattern is linear and does not overscan the edges of the screen by more than three-fourths of an inch. A recheck of the high voltage should then be made.

Preliminary Convergence Adjustments

Before any color purity adjustments can be made, it is necessary to make some preliminary convergence adjustments. These adjustments were not necessary with the electrostatic convergence picture tube as the gun structure restricted the movement of the beams and they could not be too far out of line. In the magnetic convergence tube, however, the gun structure does not restrict the beam movement and it is possible for one or more of the beams to be so far out of line that purity adjustments would be impossible.

Connect the output of a white-dot generator to the receiver and make the necessary adjustments to obtain a stable pattern. The screen and background controls for the three guns can be adjusted as necessary to make all of the color dots visible and the same size.

The dynamic convergence controls are now set to their minimum positions. In most receivers, the controls that are labeled "amplitude" should be set to the counterclockwise position and the controls that are labeled "phase" or "tilt" should be set to the mid-range position. The service data for the receiver should be consulted to obtain specific information concerning the setting of the dynamic controls for minimum correction if any difficulty is encountered.

The three static convergence magnets and the blue lateral corrector magnet are now adjusted to cause the dot trio in the center of the screen to converge into a single white dot. The solid arrows of Figure 10 indicate the motion of the dots as the static convergence magnets are adjusted. The dotted arrow shows the motion of the blue dot as the blue lateral corrector magnet is adjusted. The remainder of the dot trios on the screen will not be converged at this time and they can be disregarded. The easiest way to obtain convergence of the three dots in the center is to adjust the red and green static convergence magnets until the red and green dots converge into a yellow dot. The blue static convergence magnet and the blue lateral corrector magnet can then be adjusted to converge the blue dot with the yellow dot to form a single white dot.

This dynamic mutual conductance tube tester is very useful. It tests the tube for present quality and forecasts the future life of the tube under normal operating conditions.

Courtesy Hickok Electrical Instrument Co.

At all times during these adjustments, maintain the contrast, brightness and focus controls at the proper settings for sharp reproduction of the dots.

Purity Adjustments

The purity adjustments for the magnetic convergence picture tube are the same as for the electrostatic convergence tube. However, some of the components that are used in conjunction with the magnetic convergence tube may be different depending upon the manufacturer of the receiver. For example, the purity coil may be replaced by a purity magnet which consists of two magnetic rings that can be rotated individually around the neck of the tube even though the rings are placed together in one assembly. Another difference in components is that the field neutralizing coil may be replaced by permanent magnets that are equally spaced around the front of the picture tube.

To start the purity adjustments, the field neutralizing control is set to its minimum correction position which is usually the center of its adjustment range; or the rim magnets are positioned for minimum effect by moving them away from the tube as far as possible. The deflection yoke can now be loosened and moved as far toward the base of the tube as possible without disturbing the position of the purity coil.

As in the electrostatic convergence tube, the red phosphor is the most inefficient and the purity adjustments are made while observing the red field. Therefore, the blue and green screen controls are set to their maximum counterclockwise positions and the red screen control turned fully clockwise. The contrast control is turned fully counterclockwise and the brightness control turned fully clockwise.

For best results the magnetic field produced by the purity device should be as weak as possible and still obtain good purity. If the receiver uses a purity coil, the purity control is turned fully counterclockwise. If the receiver uses a purity magnet, the two rings must be positioned for the weakest field. Each ring of the purity magnet normally has a tab for the north pole and a tab for the south pole. When the north pole tabs are adjacent to each other and the south pole tabs are adjacent to each other, the field strength is maximum. When a north pole tab and a south pole tab are adjacent to each other, the field strength is minimum. If the tabs are not identified, place the tabs of the rings adjacent to each other and turn both rings together around the neck of the picture tube while the raster is being examined. If the colors observed change considerably as the rings are rotated, they are incorrectly set and one ring should be rotated 180 degrees with respect to the other. When the rings are set properly for minimum field strength, rotation of the rings together causes very little change in the colors appearing on the screen.

After the purity device has been adjusted for minimum magnetic field, rotate it around the neck of the tube until a pure red area is produced in the center of the raster. If this cannot be done, increase the current through the purity coil or increase the strength of the field produced by the purity magnet. In the latter case this can be done by turning one ring slightly to cause a space between the tabs. Again rotate the purity device to obtain a pure red area in the center of the screen. This process of increasing the field strength of the purity device and rotating it is continued until the desired results are obtained.

Next move the yoke forward until the largest red area is obtained. Disregard impurities around the edges of the screen. It may be necessary to readjust the purity device slightly after the yoke has been moved forward. Now the rim magnets or the field neutralizing control should be adjusted so that the edges of the screen are also pure red. When rim magnets are used, only the magnets in the vicinity of the contamination need be adjusted.

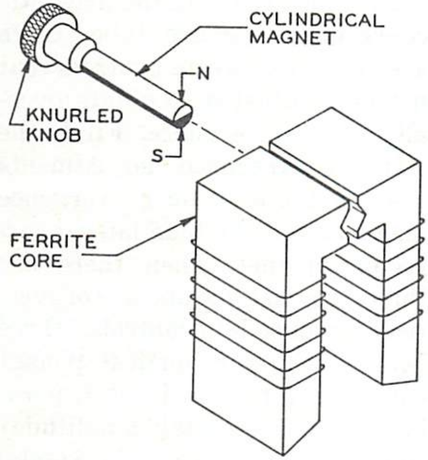
Finally, the purity of the blue and green fields can be checked by turning down the red screen control and turning up the blue screen control; then turning down the blue screen control and turning up the green screen control. In each case, the raster should be examined for impurities and the purity procedure repeated, if necessary. Adjust all of the screen controls to produce a dim white raster.

Convergence Adjustments

In receivers using the magnetic convergence picture tube, there are sixteen separate controls that must be adjusted to obtain overall beam convergence. First, the static convergence adjustments are the three static convergence magnets and the blue lateral corrector magnet. Then there are three vertical parabola (or vertical amplitude) controls, three vertical tilt (or vertical phase) controls, three horizontal parabola (or horizontal amplitude) controls and three horizontal phase (or horizontal tilt) controls.

To start, the amplitude or parabola controls are set to their maximum counterclockwise positions and the phase or tilt controls are set to their mid-range positions. If adjustable coils are used for the horizontal phasing controls, they are left as is.

Next, feed the output of a white-dot generator into the receiver and make all the necessary adjustments to lock the dot pattern in place. If any of the dots are not visible adjust the screen controls to make them appear. Adjust the contrast, brightness and focus controls for a clear, sharp pattern. It is also a good idea to have the room illumination low so that the pattern is clearly visible without the brightness and contrast controls set too high.



A detailed drawing of the ferrite core, magnet and coil assembly used with each gun of the three-gun picture tube to obtain convergence of the beams.

Check the convergence of the center dot trio and adjust the static convergence magnets and the blue lateral corrector magnet so that the three dots converge into a single white dot. At this point in the procedure, the dot pattern will be converged in the center of the screen and mis-converged at the edges. Figure 11 illustrates how a single vertical row and a single horizontal row of dot trios should appear.

Convergence of a vertical row of dots through the center of the screen is made next. Set the red vertical amplitude control to maximum and adjust the red vertical tilt control to obtain maximum displacement of the red dots at the center of the screen. This condition is shown in Figure 12.

Adjust the green vertical amplitude control to maximum and the green vertical tilt control to obtain maximum displacement of the green dots at the center of the screen also as shown in Figure 12. Since the position of the blue beam is not important while making these adjustments, the blue screen control can be set to cut off the blue gun. This may facilitate the adjustments a little.

Reduce the setting of the red vertical amplitude control so that the red dots form a straight vertical line as shown in Figure 13. If necessary, the red vertical tilt control and the red vertical amplitude control can be readjusted a little for best results.

Reduce the setting of the green vertical amplitude control so that the green dots form a straight vertical line also as shown in Figure 13. The green vertical tilt and green vertical amplitude controls also can be readjusted slightly to obtain a straight line of green dots.

Next, adjust the red and green static convergence magnets so that the red and green dots in the center of the vertical line converge into a yellow dot. At this point, all of the other red and green dots along this same vertical line should be converged to form yellow dots. If they are not, a slight readjustment of the red and green tilt and amplitude controls must be made.

Now increase the setting of the blue screen control so that the blue dots reappear. Turn the blue vertical amplitude control to maximum and adjust the blue vertical tilt control so that the blue dots in the center vertical line are all misplaced an equal amount with respect to the yellow dots. It may be necessary to reduce the setting of the blue vertical amplitude control slightly and once again adjust the blue vertical tilt control for the desired results. Figure 14 illustrates the appearance of the vertical line of dots when these controls are properly adjusted. It is possible for the yellow and blue dots to overlap slightly to form a white portion between them. In any case, the important point is that the blue dots occupy the same relative position in respect to the yellow dots regardless of the actual amount of separation.

The blue static convergence magnet and the blue lateral corrector magnet are now adjusted to converge the blue dots with the yellow dots and cause the center vertical line to be white dots.

Next in sequence are the horizontal convergence adjustments which are similar to the vertical adjustments. If the center dot is not white due to mis-convergence, adjust the static convergence magnets and the blue lateral corrector magnet to form a white dot in the center of the screen. Figure 15 illustrates the approximate positions of the dots along the center horizontal line before dynamic convergence adjustments are made.

Adjust the blue horizontal amplitude control to maximum and adjust the blue horizontal phasing control to cause a maximum downward movement of the blue dots at the center part of the horizontal line. Now reduce the setting of the blue horizontal amplitude control to make the blue dots form a straight horizontal line as indicated in Figure 16. Disregard the positions of the red and green dots during these adjustments. If necessary, the blue horizontal phasing control may be readjusted slightly to obtain the desired results.

To facilitate adjustment of the red and green dynamic convergence controls, one set of dots can be reduced below screen illumination while the other set is being adjusted. Accordingly, reduce the screen voltage on the green gun and a pattern similar to Figure 17 should be obtained. Adjust the red horizontal amplitude control fully clockwise and the red horizontal phase control for maximum upward motion of the red dots in the center of the horizontal line.

The red horizontal amplitude control is now reduced to make the red dots form a straight line across the center of the screen and occupy the same relative positions with respect to the blue dots as indicated in Figure 16 (Disregard the green dots in this Figure). Once this pattern has been achieved, reduce the setting of the red screen control and increase the setting of the green screen control so that the green dots are of normal intensity. At this point the center horizontal line of dots should appear as in Figure 18.

Turn the green horizontal amplitude control to its maximum clockwise position and adjust the green horizontal phase control for maximum upward motion of the green dots in the center of the horizontal line.

The green horizontal amplitude control is adjusted to make the green dots form a straight line across the center of the screen and occupy the same relative position with respect to the blue dots as shown in Figure 16 (This time disregard the red dots in the Figure).

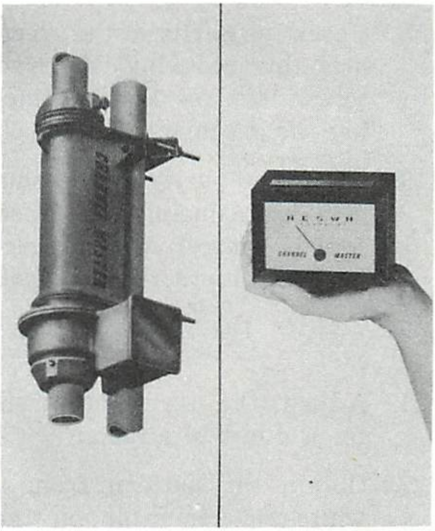
Increase the setting of the red screen control to make the red dots reappear. The horizontal line of dots should now appear as shown in Figure 16. It may be necessary to readjust one or more of the dynamic convergence controls to produce a triangular pattern of dots all the way across the screen. It is not necessary that each trio be an equilateral triangle as shown in Figure 16 but it is necessary that each trio have the same triangular pattern.

Once this has been accomplished, the static convergence magnets and the blue lateral corrector magnet are adjusted to cause the center dot trio to converge into a single white dot. At the same time, all of the other dot trios on the entire screen should also converge into white dots. If they do not, it indicates that the dynamic convergence adjustments are not correct and should be readjusted as necessary. There is a possibility however, that a slight color fringing at the outermost edges of the screen cannot be corrected on some receivers. In most cases, the amount of this color fringing should not be sufficient to cause any noticeable deficiencies in the reproduced picture.

Summary of Set-up Adjustments

A brief summary of the step-by-step procedure for making the set-up adjustments is as follows:

1. Tune in a strong local station and adjust the agc circuits.
2. Check the action of the horizontal circuits and adjust if necessary.
3. Turn brightness and contrast controls to minimum and adjust the high voltage for about 25,000 volts.
4. Check high voltage regulation while rotating the brightness control.
5. Adjust the size, linearity, focus, and centering controls while observing a crosshatch or other suitable pattern.
6. Feed a white-dot signal to the receiver.
7. Adjust contrast, brightness and screen controls for a good pattern.
8. Set all dynamic convergence controls to their minimum correction positions. If horizontal phasing controls are adjustable coils, leave them as is.
9. Adjust the red and green static convergence magnets to make the red and green dots converge and form a yellow dot in the center of the screen.
10. Adjust the blue static convergence magnet and the blue lateral correction magnet to converge the blue and yellow dots into a white dot in the center of the screen. Disregard the dot patterns elsewhere on the screen.
11. Set the rim coil control or rim magnets for minimum effect.



The rotor and control unit in this photo will be found on many antenna installations that are used for color TV receivers.

Courtesy Channel Master Corp.

12. Move the deflection yoke back as far as possible.
13. Turn the contrast, blue screen and green screen controls to their maximum counter clockwise positions.

14. Turn the red screen control and the brightness control fully clockwise.
15. Adjust the purity coil and control or the purity magnet for a pure red area in the center of the screen.
16. Move the deflection yoke forward until the largest pure red area is obtained.
17. Adjust rim coil control or rim magnets to eliminate impurities at edges of screen.
18. Check the purity of the green field by reducing the red screen control and advancing the green screen control.
19. Check the purity of the blue field by reducing the green screen control and advancing the blue screen control.
20. Tighten the yoke into position.
21. Adjust the screen controls for a dim white raster.
22. Obtain the pattern from a white-dot generator on the receiver screen.
23. Set all dynamic convergence controls for minimum correction.
24. Adjust the static convergence magnets and the blue lateral corrector magnet to converge the dot trio at the center of the screen into a white dot.
25. Cut off the blue beam by reducing the blue screen control.
26. Set the red and green vertical amplitude controls to maximum.
27. Set the red and green vertical tilt controls to obtain maximum displacement of the red and green dots at the middle of the center vertical line of dots.
28. Adjust the red and green vertical amplitude controls to make the red and green dots form straight vertical lines.
29. Adjust the red and green static convergence magnets to cause the red and green dots in the middle of the center vertical line to converge into a yellow dot.
30. If the entire center vertical line of dots is not yellow, readjust the vertical convergence controls as necessary.
31. Increase the setting of the blue screen control to make the blue dots visible.
32. Adjust the blue vertical amplitude control and the blue vertical tilt control so that the blue dots in the center vertical line are misplaced an equal amount from the yellow dots.

33. Adjust the blue static convergence magnet and the blue lateral corrector magnet to converge the center vertical line of blue dots with the center vertical line of yellow dots to form white dots.
34. Turn the blue horizontal amplitude control to maximum.
35. Observing only the center horizontal line, adjust the blue horizontal phase control for maximum downward movement of the blue dots at the middle of the horizontal line.
36. Reduce the setting of the blue horizontal amplitude control to form the blue dots into a straight horizontal line.
37. Reduce the setting of the screen control to cut off the green beam.
38. Turn the red horizontal amplitude control fully clockwise.
39. Adjust the red horizontal phase control for maximum displacement of the red dots from the blue dots in the center of the horizontal line.
40. Reduce the setting of the red horizontal amplitude control so that the red dots form a straight horizontal line through the center.
41. Reduce the setting of red screen control and increase the setting of the green screen control to make the green dots visible.
42. Turn the green horizontal amplitude control fully clockwise.
43. Adjust the green horizontal phase control for maximum displacement of the green dots from the blue dots in the middle of the horizontal line.
44. Reduce the setting of the green horizontal amplitude control so that the green dots form a straight horizontal line through the center of the screen.
45. Increase the setting of the red screen control to make the red dots visible.
46. Adjust the static convergence magnets and the blue lateral corrector magnet to cause all of the dot trios to converge into an all white dot pattern.

The black-and-white set-up adjustments for the magnetic convergence tube are not repeated since they are exactly the same as for the electrostatic convergence picture tube. Accordingly, steps 34 through 44 of the summary for the electrostatic set-up procedure apply in this summary.

The dot patterns illustrated in the preceding set-up adjustments have been based upon the assumption that the picture tube has the three guns positioned as shown in Figure 2. If a receiver employs a picture tube that has the guns in different positions, the color dots seen on the screen will be changed accordingly.

For example, if the guns are located as shown in Figure 19 (looking from the front of the picture tube), the dot pattern illustrated in Figure 11 would appear as in Figure 20. Notice the location of the guns in Figure 19 are exactly opposite to the gun positions of Figure 2. Therefore, the relative positions of the dots in Figure 20 are exactly opposite to the relative positions of the dots in Figure 11.

ANTENNA REQUIREMENTS

Basically, the antenna requirements for a color television receiver are the same as for a black-and-white receiver. It should be capable of providing a signal that is of sufficient strength and free of noise, reflection and interference. Also, it must have a bandwidth that will pass the entire 6 mc signal that is transmitted.

Unfortunately, some of the antennas used for monochrome reception were designed to obtain maximum gain with an accompanying decrease in bandwidth. An antenna of this type could cause the reproduced picture to have very pale colors as the chrominance information, which is at the high frequency end of the channel, would be attenuated severely. In fact, there is a possibility that no colors will be reproduced at all if the bandwidth is so narrow that the color burst signal is not passed. In receivers using a color killer, lack of the burst would cause the chrominance channel to be cut off and none of the color information would get through.

Another important factor concerning the antenna is the problem of reflected signals being received along with the direct signal. In black-and-white reception, reflected signals appear merely as a ghost whereas, in color reception, it is possible for the reflected signal to cause cancellation of the burst and result in no color. Accordingly, it becomes necessary to orient the antenna more carefully. In fact, if color reception is desired from stations that are located in different directions from the receiving antenna, the best results are obtained by using an antenna rotator.

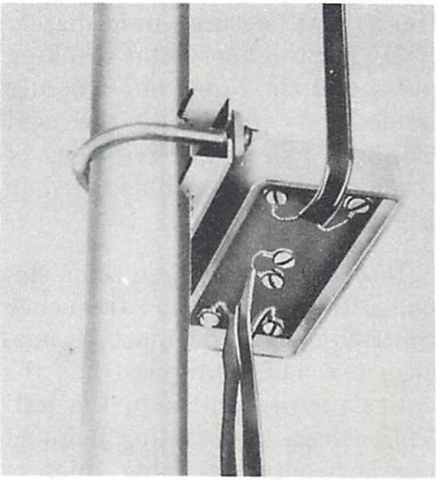
In some localities it is necessary to employ a booster to increase the signal strength to a level where it is usable. Before installing any booster, be sure that it has sufficient bandwidth to pass all of the information contained in the transmitted signal. This means the bandwidth must be a full 6 mc. A booster having insufficient bandwidth can cause a complete loss of color information.

A good percentage of the color television receivers will be installed in places where a black-and-white receiver is already being used. The existing antenna can also be used for the color receiver if each receiver is isolated from the common transmission line. This is done by the method shown in Figure 21 when the receiver is designed for a 300 ohm transmission line. If the receiver signal input is designed for a 72 ohm transmission line, 39 ohm (standard values) resistors are used in place of 150 ohm resistors.

As to the transmission line, standard good practices should be observed. Use a good quality line and sufficient stand-offs to keep the line from touching the sides of the building and other large objects.

USE OF THE COLOR STRIPE

After the receiver has been checked for its ability to reproduce a black-and-white picture, it must be checked for its ability to reproduce a color picture. This is done by feeding the signal from a color-bar generator into the receiver and adjusting the hue control and color saturation control for the desired colors. This procedure will prove that the receiver is capable of properly reproducing a color picture. However, it does not prove that the antenna system is capable of supplying the proper signal to the receiver to reproduce a color picture. Therefore, it is necessary that a final check of the receiver operation be made while a color signal is being transmitted.



The antenna coupler pictured here is used when it is desired to feed two TV receivers from one antenna. Proper impedance matching and isolation networks are built-in features.
Courtesy JFD Mfg. Co., Inc.

Unfortunately, color transmission in many localities is restricted to a few hours a week or a day and these occur mostly in the evening. These circumstances often cause a considerable amount of inconvenience to both the customer and the technician.

To overcome these difficulties, many stations are now transmitting a color stripe along with the regular black-and-white picture. This color test signal or color stripe consists of two bursts of about eight cycles at the color subcarrier frequency of 3.58 mc. One burst occurs immediately following the horizontal blanking pulse and the other burst occurs immediately preceding the next blanking pulse. The positions of the burst pulses is illustrated in Figure 22.

In order to use these color signals, the horizontal frequency controlling circuits must be misadjusted sufficiently so that the entire picture shifts to the left. This causes the starting point of the horizontal scanning lines to be delayed. Also, the horizontal pulses which key the burst amplifiers are delayed and occur at the same time that the color burst occurs. The burst amplifier then passes the first 3.58 mc signal and applies it to the color killer and the 3.58 mc apc (automatic phase control) circuits to permit all of the color circuits to function normally. Since the chrominance amplifier is no longer cut off, the second 3.58 mc signal is then amplified as ordinary chrominance information and produces a color stripe down the right edge of the picture. If the hue control can be adjusted to make this vertical stripe greenish-yellow in color, satisfactory reception will be obtained during a regular color telecast.

Adjustment of the horizontal hold control, in some receivers, may not permit sufficient delay of the horizontal oscillator to permit use of the transmitted color stripe. Therefore, it will be necessary to misadjust the horizontal frequency slug (or capacitor) or the horizontal lock-in capacitor. In this case, mark the correct position of the control so that it can be re-set properly after checking the reception of the color stripe.

CUSTOMER INSTRUCTION

The majority of the commercial color TV receivers on the market today employ two more controls in addition to the familiar controls found on a black-and-white receiver. These are the hue control and the color saturation control. They may be labelled other than this but, regardless of what they are called, the color saturation control changes the vividness of the reproduced color and the hue control causes the reproduced colors to change from red to orange, to yellow, to green, etc.

It is the duty of the technician to instruct at least one adult member of the customer's family in the proper operation of these controls. Even though the procedure may seem exceedingly simple to the technician, it may be confusing to the customer. A good procedure is as follows:

1. On a color telecast, turn the color saturation control fully counterclockwise.
2. Adjust the regular black-and white controls for a good black-and-white picture being especially careful to set the fine tuning control properly.
3. Turn up the color saturation control until the colors appear in the picture. If no color appears, readjust the fine tuning control on the channel selector.
4. Vary the hue control for the proper colors (hues) in the picture. If a color-bar test pattern is not being transmitted, adjust the hue control for best flesh tones.
5. Readjust the color saturation control for the most natural color brightness (This will depend upon the individual tastes of the customer).

On some color TV receivers there is a possibility that color interference will occur during the reception of a black-and-white telecast. Interference of this type can be minimized by turning the color saturation control fully counterclockwise.

Besides instructing the customer on the operation of the receiver, the technician should also assist the customer in choosing the correct location for the receiver. A considerable amount of diplomacy should be employed when making suggestions to the customer as a location may already have been chosen that is very unsuitable for the placement of the receiver. In the majority of homes, the woman of the house is responsible for the arrangement of the furniture and she is very likely to choose a position which will display the beauty of the cabinet most advantageously or which will cause the receiver to harmonize with the remainder of the furniture. Quite often, this location has been chosen with no regard whatsoever as to whether optimum performance and viewing pleasure can be obtained from the receiver.

Since it is an extremely bad policy to tell the customer that he (or she) is wrong about anything, upon delivery of the receiver the technician should point out, very tactfully, certain requirements of a good location.

The receiver should be close to a wall outlet and located conveniently for the attachment of the antenna lead-in. The screen of the receiver should not be facing a direct source of sunlight as the brightness level on color TV receivers is lower than on black-and-white receivers and the picture will wash-out more readily. Along this same line, a glare from any light source should be avoided, if possible.

Another consideration, and very important one, is adequate ventilation for the receiver. The amount of heat produced by a color TV receiver is considerably more than the heat produced by a black-and-white receiver. Point out to the customer that overheating of the receiver can result in damage to the components which may result in expensive service calls. Therefore, the receiver should not be placed in a boxed-in corner where there is insufficient air circulation.

Also, due to the amount of heat generated by the receiver, it should not be placed close to a thermostat that controls the heating system. The heat produced by the receiver would cause the contacts in the thermostat to remain open and keep the heating system turned off. As a result, the remainder of the house could become very cold and the customer very unhappy.

Up to this point, the lessons on color TV have included the basic theory of operation of the components and circuits, information on the test equipment that the technician will be using, and the installation procedure. Therefore, in the lessons immediately following this one, a detailed explanation of circuit difficulties and corrective measures will be covered. Included in these explanations will be the use of the suitable test equipment in aligning the color circuits, and interpretation of the wave-forms that will be encountered in the trouble shooting procedure.

IMPORTANT DEFINITIONS

BLUE LATERAL-CORRECTOR MAGNET—Used only with the magnetic convergence picture tube to enable the blue beam to be moved laterally and cause it to converge with the red and green beams.

COLOR STRIPE TRANSMISSION—A system whereby color signals are added to a monochrome transmission to enable a greenish-yellow stripe to be obtained on color receivers. Primarily used as an aid to the technician for checking the antenna performance on a color telecast.

FIELD NEUTRALIZING COIL—A coil placed around the front of the color picture tube to neutralize the effect of the earth's magnetic field. This term is used interchangeably with "rim coil".

PURITY MAGNET—A permanent magnet used in place of the purity coil. Its field strength can be varied by rotating either of the two magnetic rings which are used in its construction.

RIM MAGNETS—Permanent magnets that are placed around the front of the picture tube to take the place of the field neutralizing coil. The group of magnets are sometimes referred to as the "color equalizer assembly".

SET-UP PROCEDURE—The complete procedure for making all of the necessary adjustments concerning the picture tube to enable a good quality black-and-white picture to be obtained. These include the high voltage, linearity, purity, convergence and black-and-white adjustments.

STATIC CONVERGENCE MAGNET—A magnet used to vary the steady or fixed magnetic field of each of the three convergence coils used with the magnetic convergence tube. These magnets are usually built-in as part of the convergence coil.

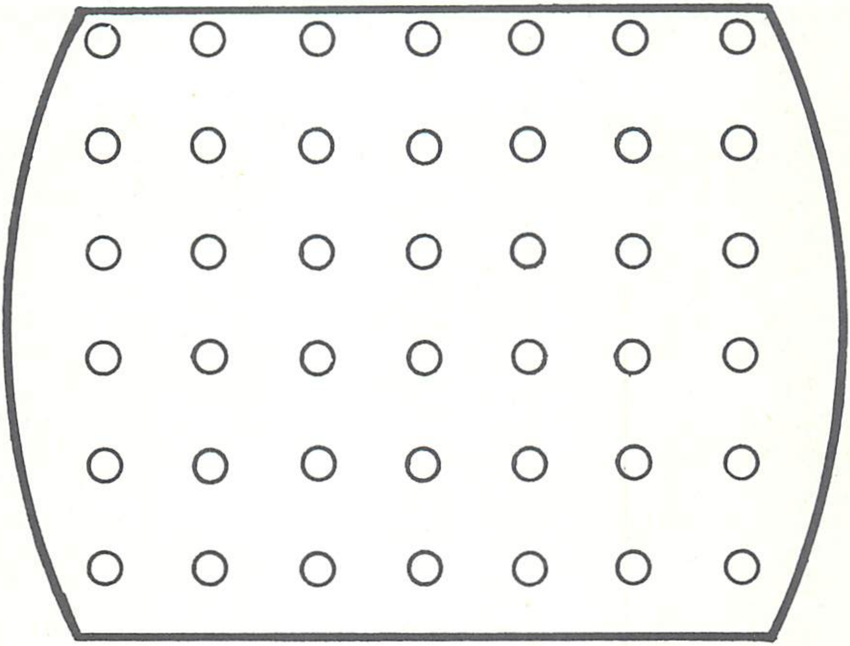


FIGURE 1

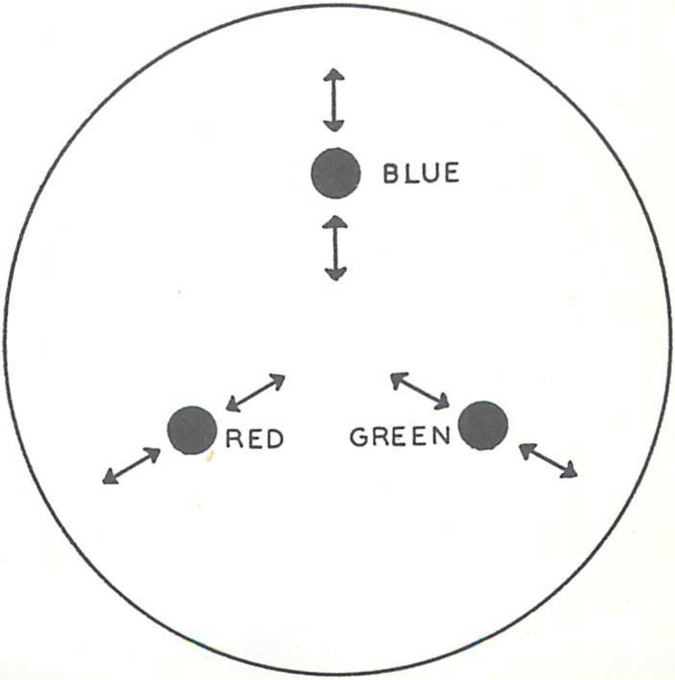


FIGURE 2

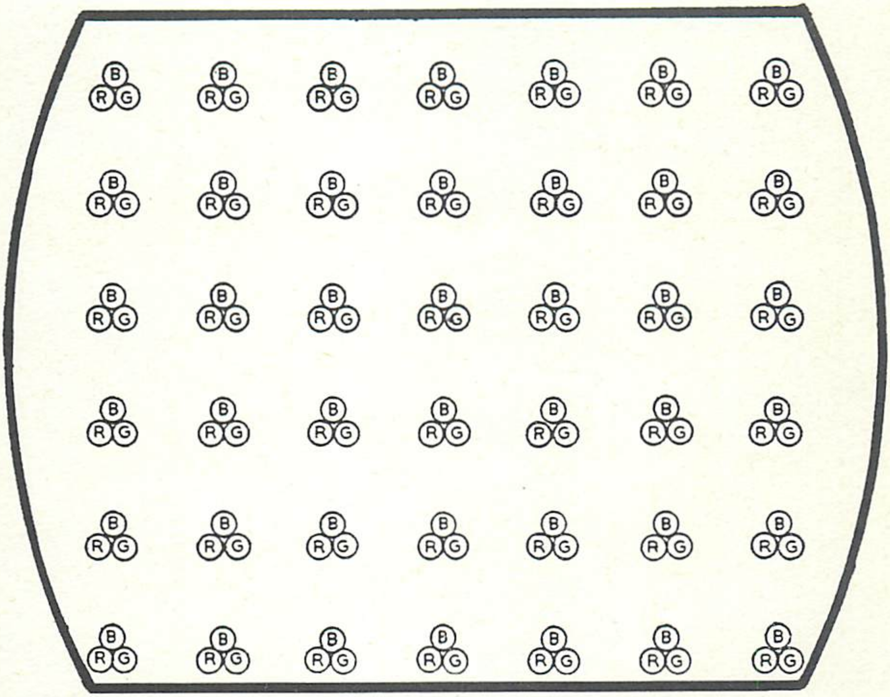


FIGURE 3

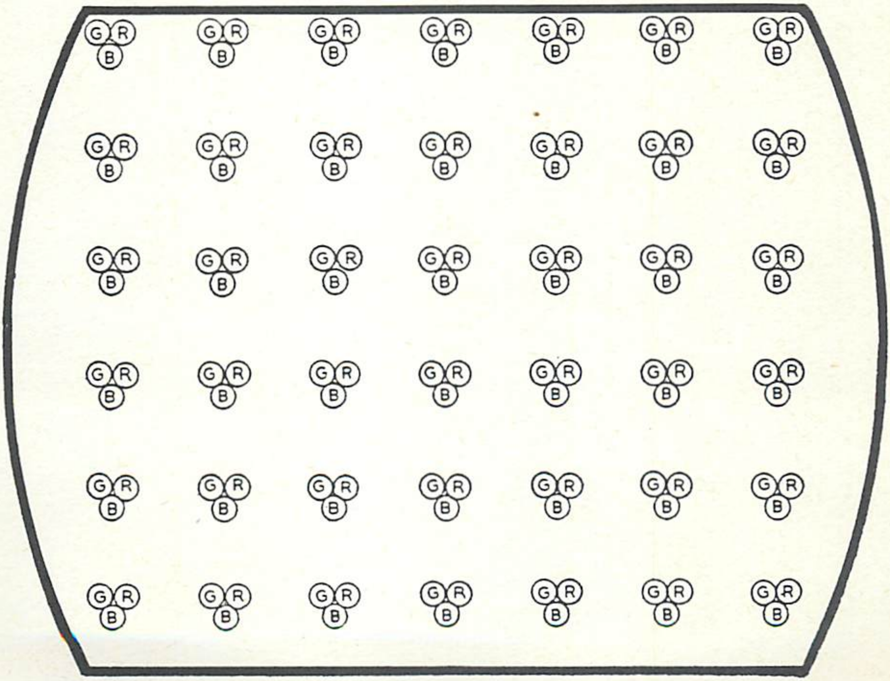


FIGURE 4

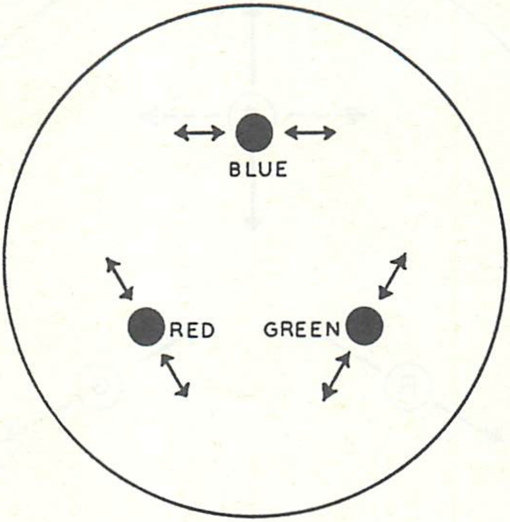


FIGURE 5

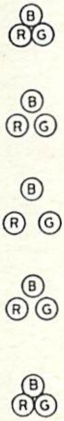


FIGURE 6

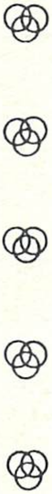


FIGURE 7

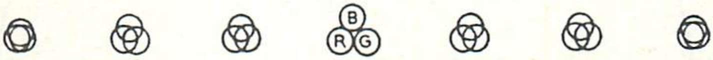


FIGURE 8

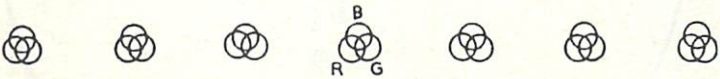


FIGURE 9

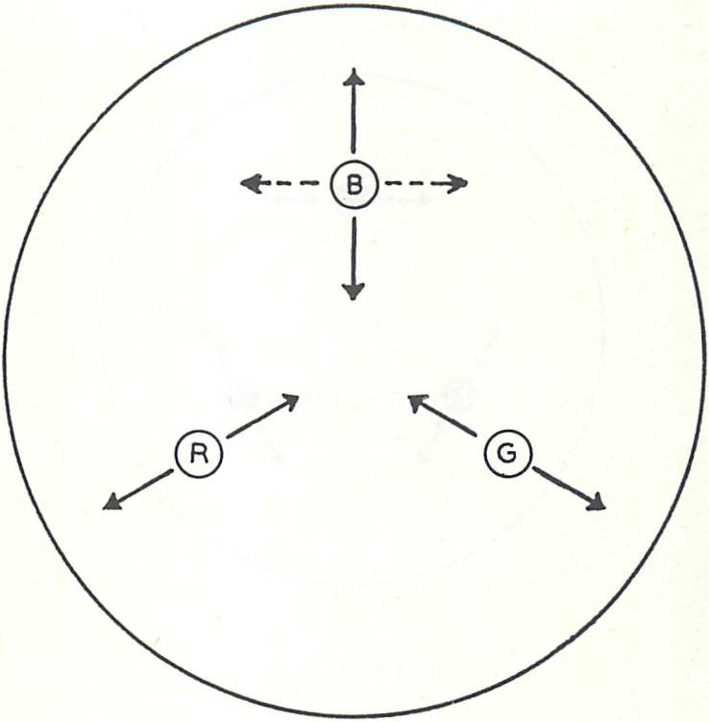


FIGURE 10

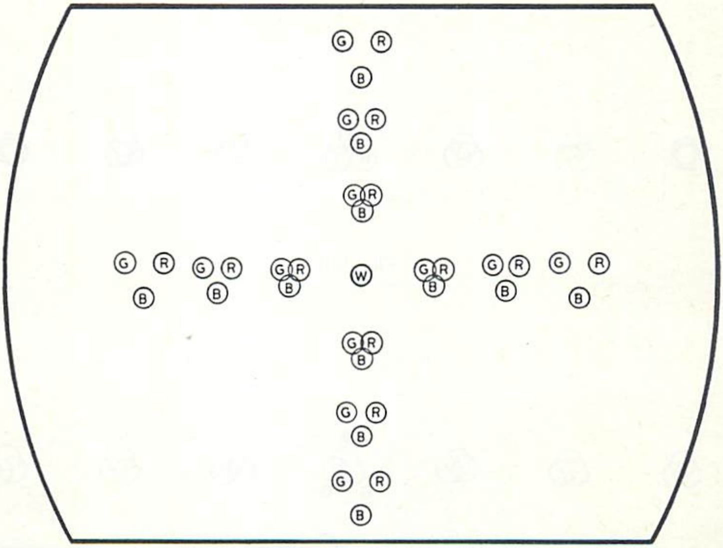


FIGURE 11

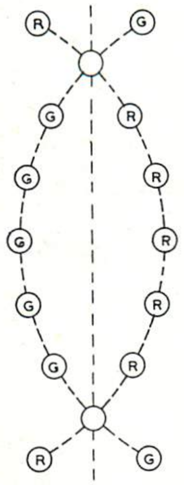


FIGURE 12

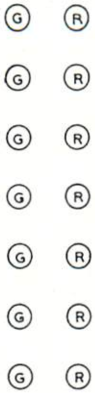


FIGURE 13

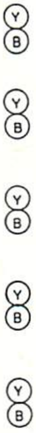


FIGURE 14

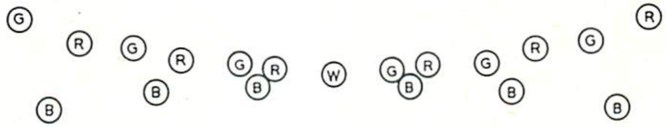


FIGURE 15

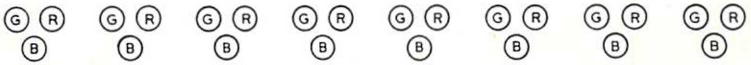


FIGURE 16

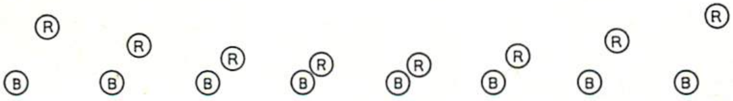


FIGURE 17

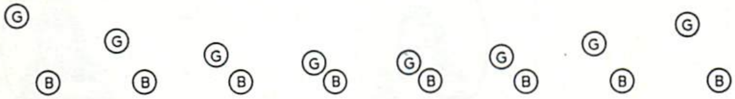
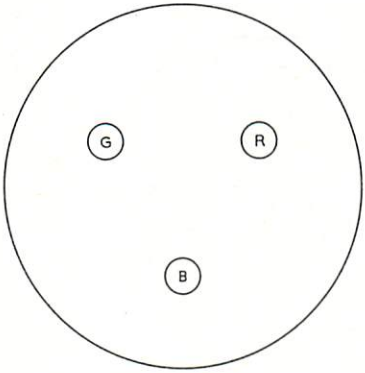


FIGURE 18



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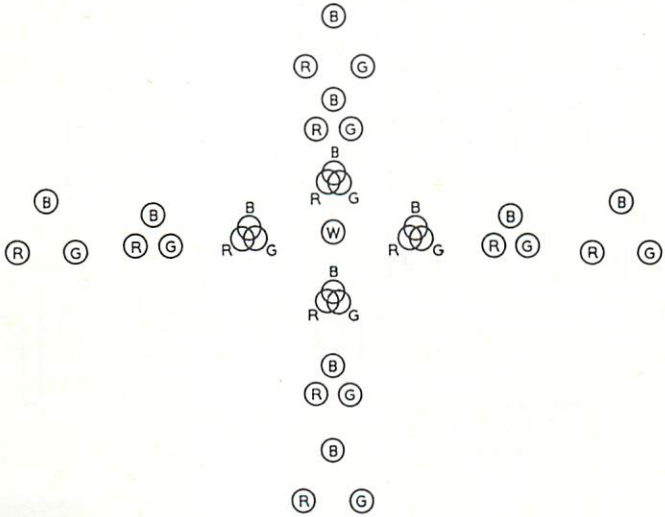

FIGURE 20

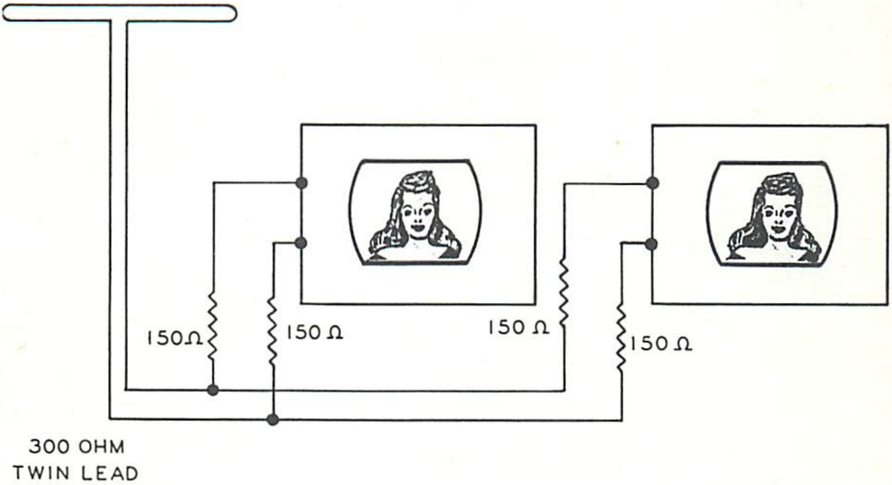

FIGURE 21

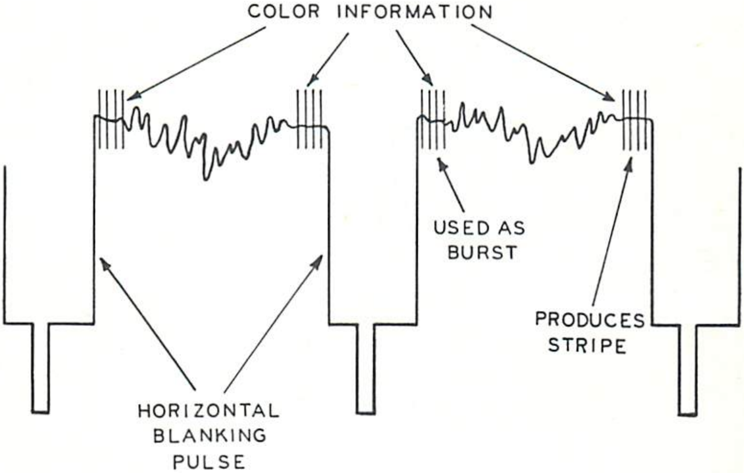

FIGURE 22

FROM OUR *Director's* NOTEBOOK

SAY WHAT YOU MEAN—
MEAN WHAT YOU SAY

What you say and how you say it in your employment interview often spells the difference between getting the job and getting the "brush off."

When you are interviewed for a job, the employer has no way of knowing whether you are a good man for the job or not. You've had no chance to demonstrate your ability to him.

Hence, you must be able to put yourself across in words FIRST before you can have the opportunity of showing the boss you're the right man.

So speak clearly, use words you are familiar with, put together good, grammatical sentences and avoid stammering. Above all, say what you mean without overstatement—and MEAN WHAT YOU SAY. Sincerity is all-important for making a good impression.

Yours for success,

W. C. DeVry

DIRECTOR

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T4